

*“Designing and Building a heat pipe demonstration unit for a mechanical engineering laboratory class at NAU”*

Senior Capstone Design-  
ME476C  
Background Presentation

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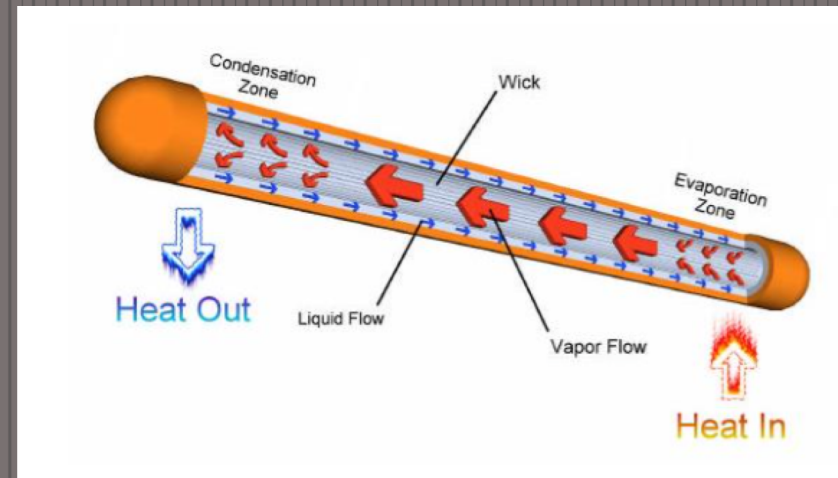


Figure [1]: Heat Pipe

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06/28/2018

# Content:

- **Project Description**
- **Background & Benchmarking**
- **Existing Designs**
- **Customer & Engineering Requirements**
- **Schedule & Budget**

# Project Description:

- What is the project about?
- Our sponsor?
- Our stakeholders?
- Why is it important?

# Background & Benchmarking:

- Definition of a heat pipe.
- Where it used?



# How a Heat Pipe Works

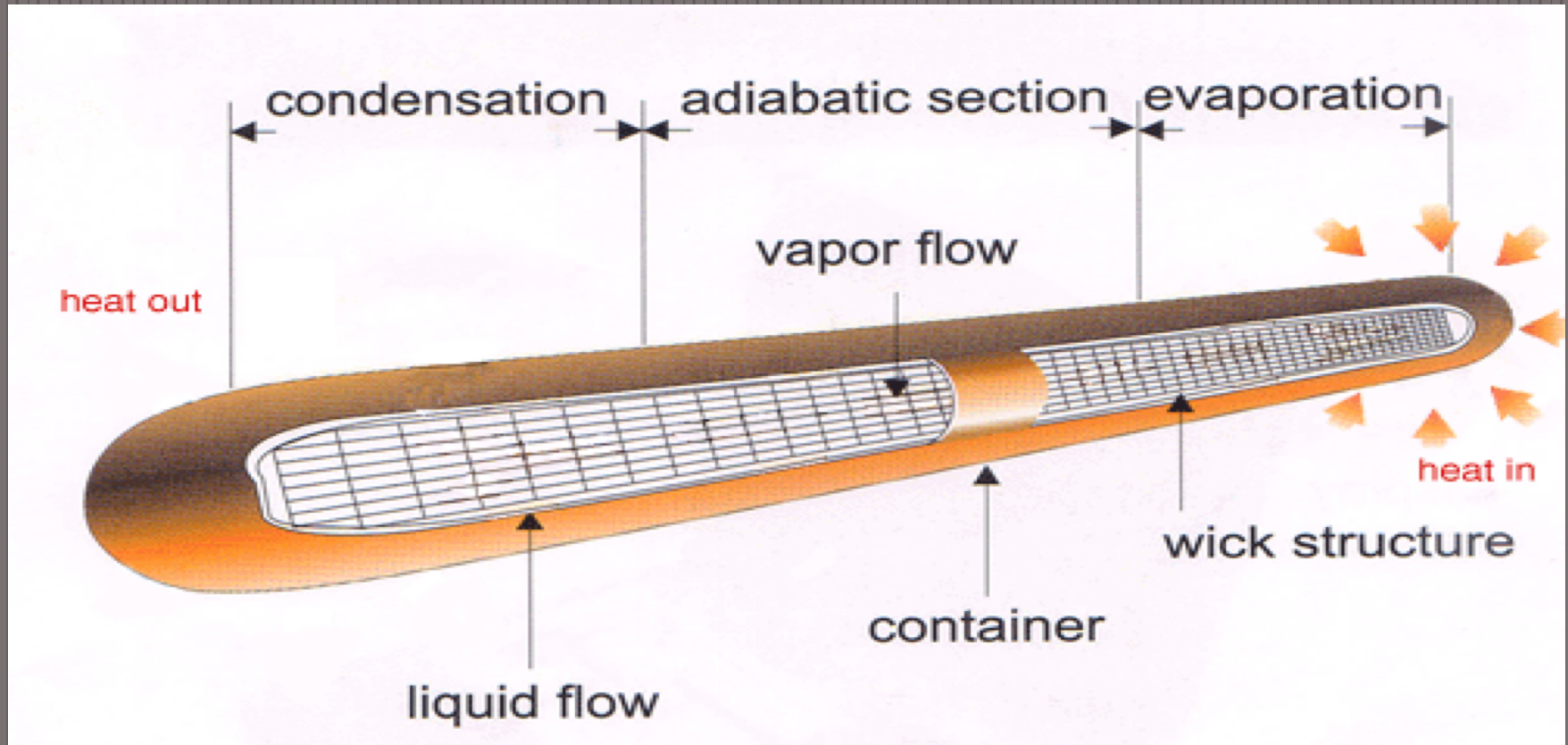


Figure [1]: Working of Heat Pipe

# Heat applications

- Heat pipe heat exchanger enhancement
- Both cooling and reheating energy
- Chemical reactions

# Different Types of Heat Pipes

- Vapor chamber or flat heat pipes
- Variable Conductance Heat Pipes (VCHPs)
- Diode Heat Pipes
- Thermosyphons
- Loop heat pipe

# EXISTING DESIGNS



Existing Design #1: uses both a local and remote heat sink

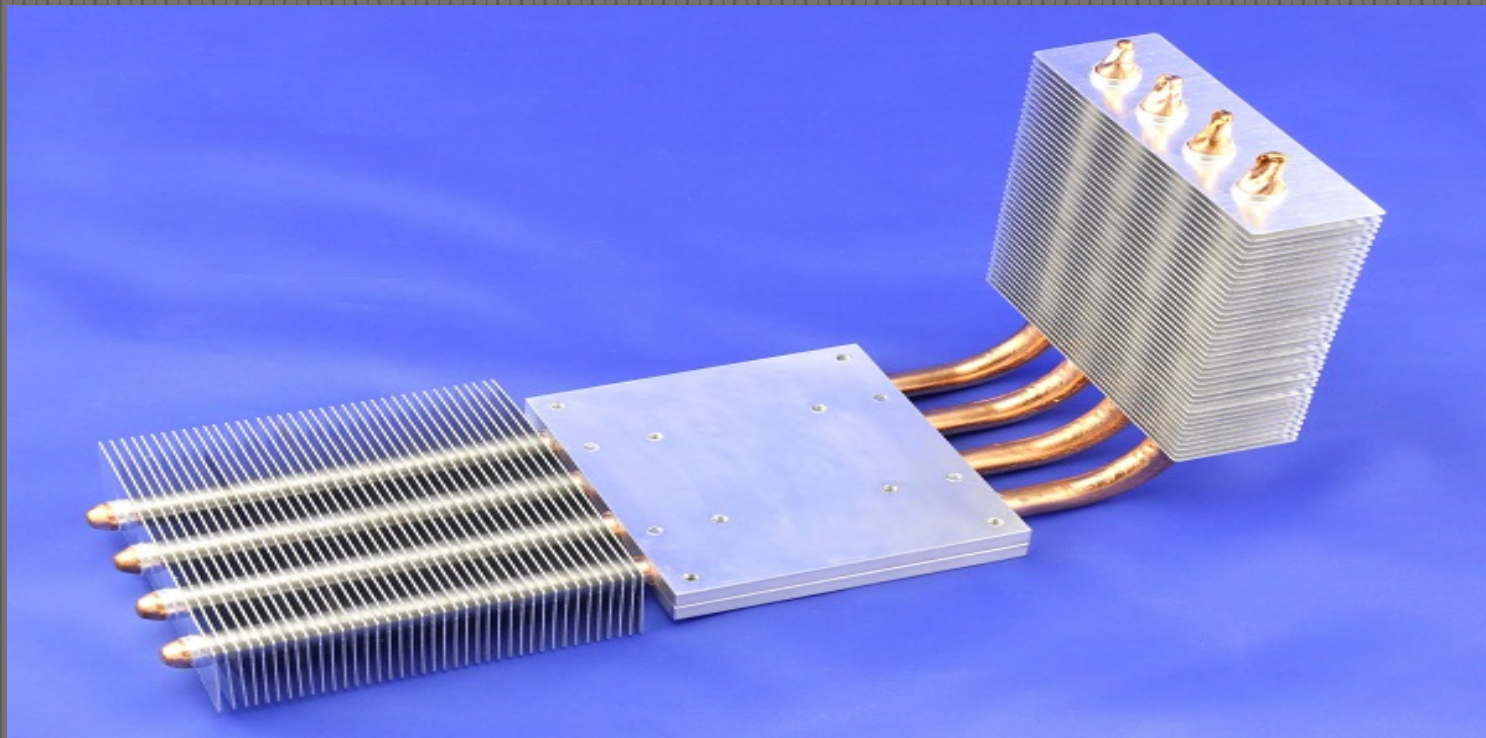


Figure [2]: local and remote heat sink

# EXISTING DESIGNS



## Existing Design #2: Grooved Mounted Block type:

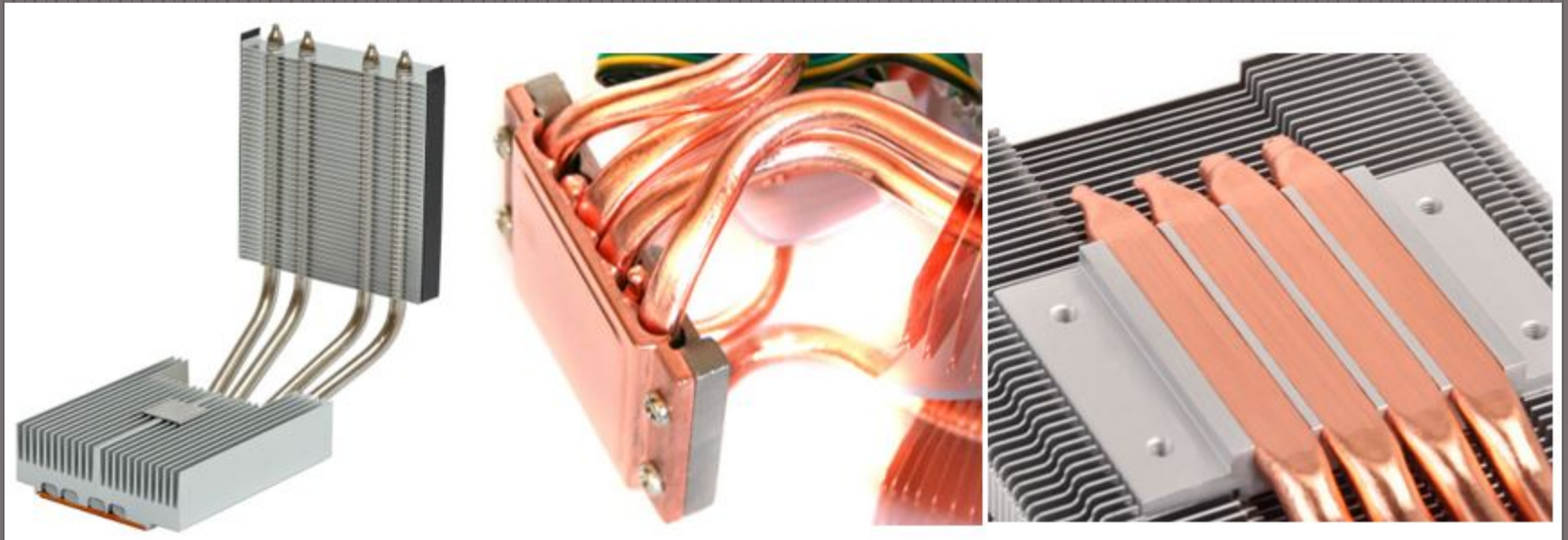


Figure [3]: Grooved Mounted Block type

# EXISTING DESIGNS



Existing Design #3: Direct Contact type Heat Pipe:

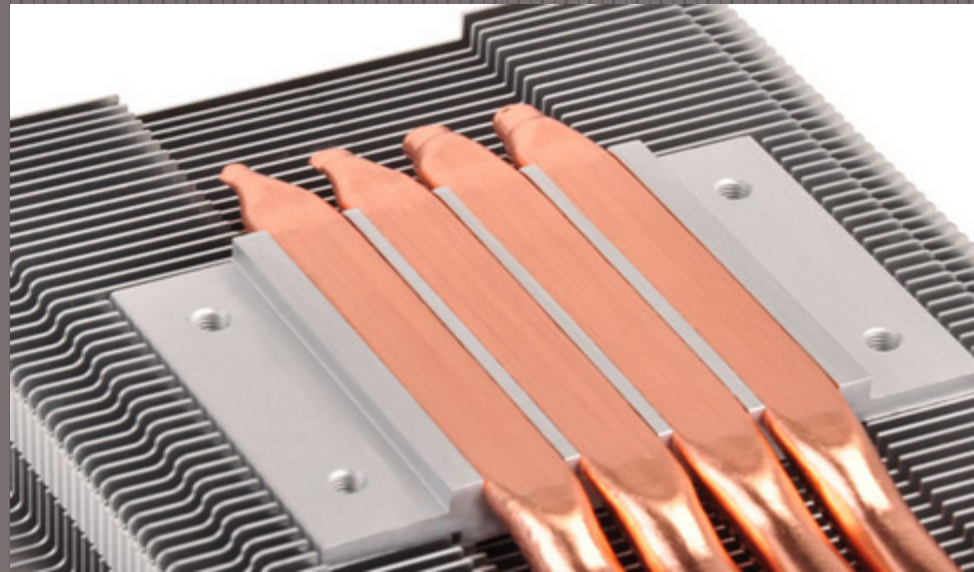


Figure [4]: Direct Contact type Heat Pipe



# Customer Requirements:

Table 1: Customer Requirements

<b>Customer Requirement</b>	<b>Description</b>	<b>Weight</b>
Durability	How long it is withstanding	0.16
Reliability	How accurate it will work	0.16
Manufacturable	Rate which it could be mass produced	0.11
Safety	How safe the heat pipe setup is for the end user	0.13
Ease of Assembly	Able to install the parts	0.14
Variability	Capable of varying with the situation	0.17
Easy to Measure	Measuring of the temperature is easy	0.13

# Engineering Requirements:

Table 2: Engineering Requirements

ERs	Description	Targets
Material Melting Temperatures	The materials must be able to withstand the maximum operating temperatures, but for safety, all temperatures will be kept below 200°C.	> 200°C
Reliability	Being able to switch fluids, pressure and wicking materials.	> 5 years
Set-up time		1 min
size	Volume, size of the set up to be useable for lap demo.	12 cubic feet
Light Weight	Must be light weight to utilize it in better way	> 5 Kg



# House of Quality (HoQ):

Table 3: HoQ

Engineering Requirements \ Customer Requirements	Importance	Material Melting Temperatures	Reliability	Setup Time	Size	Light Weight			
Durability	9	9	3	1	1	1			
Reliability	3	3	9	3	9	3			
Manufacturable	3				3				
Safety	9	3	3	3	9	1			
Easy to Assembly	9	1	1	3		3			
Variability	1		1	3	1	1			
Easy to Measure	3	1	9	9	3	3			
<b>Technical Importance: Raw Score</b>		129	118	102	136	64			
<b>Technical Importance: Relative Weight</b>		23.5%	21.5%	18.6%	24.8%	11.7%			
<b>Technical Target Value</b>		200	5	1	12	5			
<b>Upper Target Limit</b>									
<b>Lower Target Limit</b>									
<b>Units</b>		C	Years	Min	ft <sup>3</sup>	Kg			

# Schedule & Budget

## Schedule

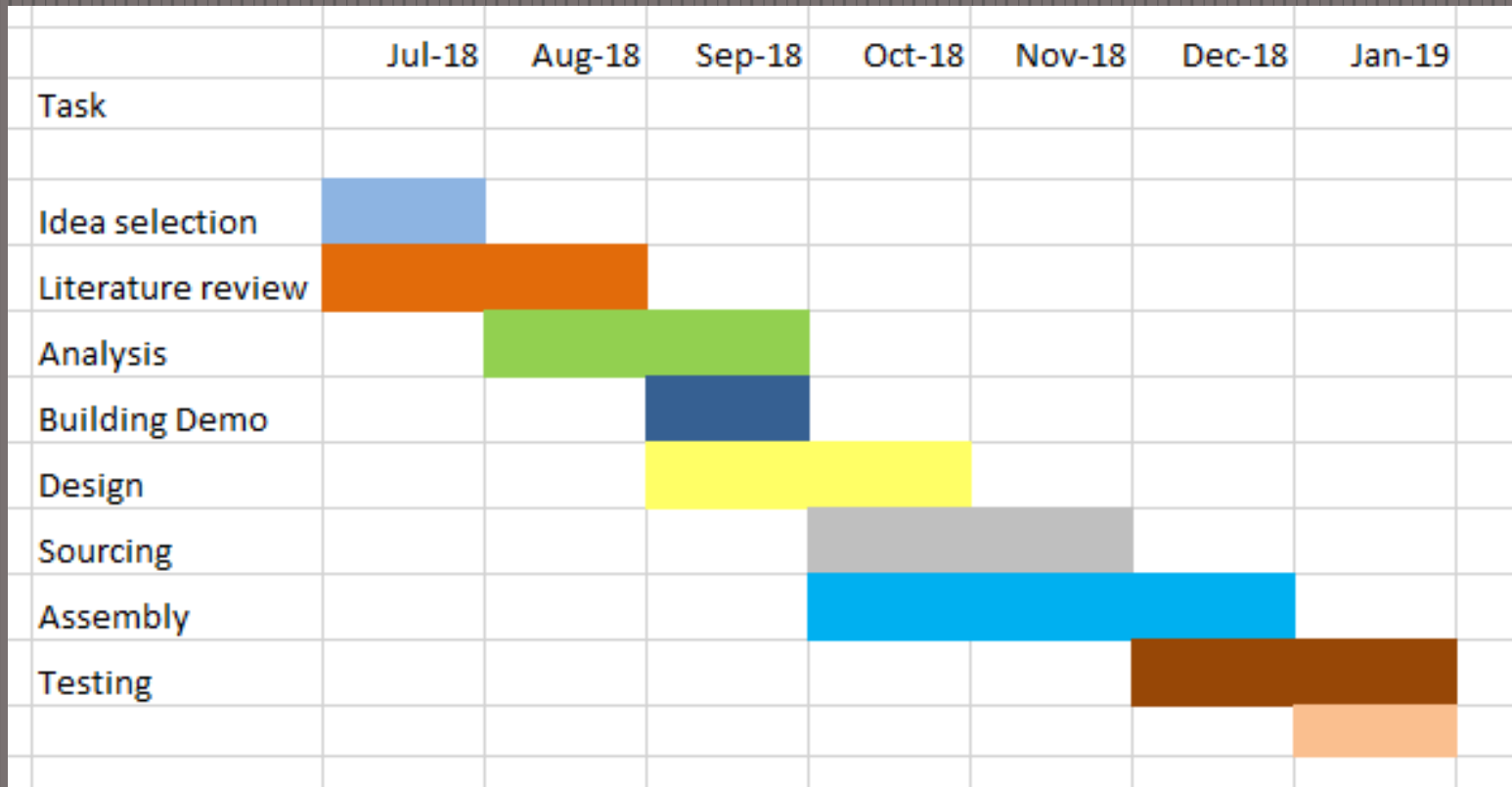


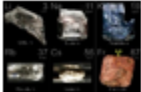






Figure 5: Schedule

# Budget

Table 4: Budget

Component Name	Model Number	Picture	Cost	Supplier
1. MISOL 10 pcs/lot of copper heat pipe (40cm), for solar water heater	<ul style="list-style-type: none"> <li>Fit for the glass tube (500mm length)</li> <li>Insert into the glass tube of</li> <li>Material: Copper</li> <li>Diameter: 14mm (Header)</li> <li>Pipe diameter: 6 mm</li> </ul>		\$ 60	<u>Misol</u>
2. Ammonia	Ammonia gas		\$ 120	Gas company
3. Alkali metals	Cesium, Potassium, Sodium		\$100	Alkali metals company

# Budget Cont...

4. K-type thermocouple	Thermocouple Type-K - Glass Braid Insulated (Bare Wire)		\$20X7 = \$140	EDWIN robotics
5. pressure regulator	GOK 2 - 180 L/hr Oil Pressure Regulator c/w Gauge		\$135	Anglo Nordic
6. Wick material	Powder Sintered Copper		\$ 25	Wake-field Vette
7. Heat Sink	Heat sink machined		\$5	Ali Baba
Total cost (\$)			\$ 585	

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Heat Pipe  
06/28/18

# References

- [1] Enertron, "Heat Pipe Products," *Enertron*, 2017. [Online]. Available: <https://www.enertron-inc.com/products/>. [Accessed: 28-Jun-2018].
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- [3] MyHeatSinks, "Heat Pipe Solutions | MyHeatSinks," *My Heat Sinks*, 2018. [Online]. Available: <https://www.myheatsinks.com/heat-pipe-solutions/>. [Accessed: 28-Jun-2018].
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- [5] Celsia, "Heat Pipes and Vapor Chambers – What's the Difference?," *Celsia*, 21-Apr-2018. [Online]. Available: <https://celsiainc.com/blog-heat-pipes-and-vapor-chambers-whats-the-difference/>. [Accessed: 28-Jun-2018].

**Thank you - Any questions?**

